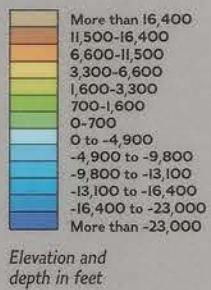


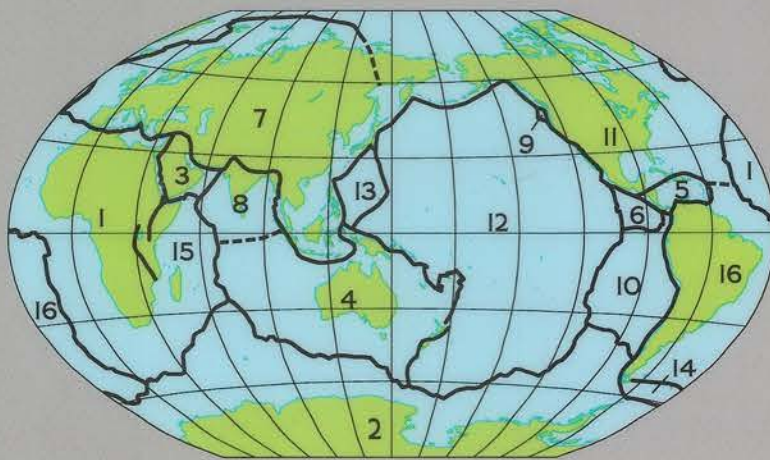
The Earth's Fractured Surface

NATIONAL GEOGRAPHIC MAPS

Winkel Tripel Projection
SCALE 1:48,000,000 or 1 INCH = 758 MILES
AT THE EQUATOR



Like the pieces of a giant jigsaw puzzle, slabs of rocky crust known as tectonic plates fit together to form the earth's outer shell. The puzzle changes as the plates slide over the hotter, softer rocks beneath them. Moving by mere inches annually, they reshape continents and ocean basins over millions of years by colliding, separating, and scraping past one another with relentless force. These interactions set off earthquakes, fire up volcanoes, and wrinkle the earth's crust into mountains, valleys, and deep-sea trenches.



- Major Plates**
- 1 African
 - 2 Antarctic
 - 3 Arabian
 - 4 Australian
 - 5 Caribbean
 - 6 Cocos
 - 7 Eurasian
 - 8 Indian
 - 9 Juan de Fuca
 - 10 Nazca
 - 11 North American
 - 12 Pacific
 - 13 Philippine
 - 14 South American
 - 15 Somali
 - 16 South Atlantic

Tectonic Features

- Strike-slip fault (formed when slabs of rock slide horizontally past each other)
- Thrust fault (formed when slabs of rock press together, forcing one side over the other)
- Fracture zone
- Subduction zone with direction of plate movement
- Spreading center with direction of plate movement
- Hot spot with motion of overlying plate (inch/year)

Notable Earthquakes of the 20th Century: 1906-1997

	Deaths		Deaths
1906 San Francisco, California 7.7	3,000	1976 Tangshan, China 7.4	655,000
1908 Messina, Italy 7.0	100,000	1980 El Asnam, Algeria 7.1	2,590
1920 Gansu and Shaanxi, China 8.3	200,000	1985 Michoacán, Mexico 8.1	9,500
1923 Tokyo, Japan 7.9	142,810	1988 Armenia 6.8	25,000
1927 Qinghai, China 7.7	200,000	1989 Loma Prieta, California 7.0	62
1935 Quetta, Pakistan 8.1	30,000	1990 Western Iran 7.5	50,000
1939 Erzinjan, Turkey 7.6	32,700	1992 Landers, California 7.3	1
1948 Fukui, Japan 6.9	5,390	1993 Latur, India 6.2	9,750
1960 Southern Chile 9.5	5,700	1994 Northridge, California 6.7	60
1964 Southern Alaska 9.2	131	1994 Northern Bolivia 8.3	10
1970 Northern Peru 7.5	67,000	1994 Kuri Islands, Japan 8.3	10
1971 San Fernando, California 6.7	58	1995 Kobe, Japan 6.9	5,200
1976 Mindanao, Philippines 8.1	8,000	1996 Yunnan, China 6.5	251
1976 Guatemala 7.6	22,780	1997 Northern Iran 7.1	1,657

Magnitudes listed above are on the moment-magnitude scale.

Notable Volcanic Eruptions of the 20th Century: 1902-1997

- 1902 Soufrière, St. Vincent
- 1902 Mount Pelée, Martinique
- 1902 Santa María, Guatemala
- 1907 Ksudach, Kamchatka, Russia
- 1911 Taal, Luzon, Philippines
- 1912 Katmai/Novarupta, Alaska
- 1914 Lassen Peak, California
- 1919 Kikai, Japan
- 1930 Merapi, Java, Indonesia
- 1932 Quilapú, Chile
- 1943 Parícutin, Mexico
- 1951 Lamington, Papua New Guinea
- 1951 Bezymyanne, Kamchatka, Russia
- 1963 Surtsey, Iceland
- 1963 Agung, Bali, Indonesia
- 1980 Mount St. Helens, Washington
- 1982 El Chichón, Mexico
- 1985 Nevado del Ruiz, Colombia
- 1991 Pinatubo, Luzon, Philippines
- 1991 Cerro Hudson, Chile
- 1994 Rabaul Caldera, Papua New Guinea
- 1995 Mount Ruapehu, New Zealand
- 1996 Grimsvötn, Iceland
- 1997 Soufrière Hills, Montserrat

Earthquakes

Most quakes occur near plate boundaries, where rock grinds past rock. Friction keeps the plate edges from sliding smoothly. The longer they remain stuck, the more strain builds and the more violent the snap and resulting vibrations—the earthquake. This map shows 20th-century quakes greater than magnitude 6.0 that originated within 60 miles of the surface.

Spreading Centers

As tectonic plates move apart, magma rises in the resulting rift, hardens, and is pulled aside, making way for more magma. Under the oceans this process has created the 46,600-mile-long Mid-Ocean Ridge system, segmented by faults, that snakes around the globe. On land the process has created—and continues to widen—the East African Rift System.

Subduction Zones

When two plates collide, one often dives beneath the other—a process called subduction. Oceanic plates subduct under continents and perhaps under other oceanic plates as well, forming trenches that mark their descent. Where continental plates run into each other, they buckle, creating ranges such as the Himalayas.

Transform Faults

Sometimes tectonic plates shift past each other horizontally at a boundary known as a transform fault—a distinct type of strike-slip fault. The San Andreas, for example, accommodates movement fitfully along its several hundred miles—slow creep in some places, frequent small jumps or rare big ones in others.

Volcanoes

Magma rises to the surface from inside the earth mainly at subduction zones and spreading centers. The edge of the Pacific Basin—the 30,000-mile-long Ring of Fire—is especially volatile, with about 70 percent of the world's more than 500 historically active volcanoes. This map shows all known eruptions over the past 10,000 years.

Hot Spots

In a scattering of places, magma burns through a tectonic plate. Each hot spot likely marks the top of a plume of semimolten rock that rises many hundreds of miles inside the earth. As a plate slowly passes above, the plume melts into it, creating a chain of volcanoes such as those in the Hawaiian Islands.